Collins

51J-4
COMMUNICATION RECEIVER

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51J-4 in Table Mounting Cabinet

The Collins 51J-4 Communication Receiver is the latest model of a series of general purpose receivers which have found wide application all over the world in the various communication services. Proven performance characteristics such as crystal controlled oscillators, accurate linear dial calibration and excellent overall stability are supplemented by an entirely new approach to the attainment of nearly ideal selectivity. Resonant mechanical elements rather than tuned electrical circuits are used as an IF filter resulting in an almost rectangular selectivity curve. This Mechanical Filter provides a desirable operational tool in the reception of signals during conditions of severe adjacent channel interference or noise.

Provision is made for three Mechanical Filters, any one of which may be selected by a front panel control to obtain the desired bandwidth. A 1.4 kc Mechanical Filter offers proper selectivity for CW operation. A 3.1 kc Filter is most suitable for voice communication and where high fidelity broadband characteristics are desired, the 6 kc Filter may be selected. An essentially flat top and sharp cutoff at the sides of the selectivity curve of the Mechanical Filter permit AM signals to be tuned to accept the carrier and either one of the sidebands at will, while the other sideband and any signals that are interfering with it are eliminated.

The tuning range of the receiver, .54 to 30.5 megacycles, is divided into 30 one-megacycle bands selected by a "megacycle" knob and indicated on a linear dial scale having 100 kc graduations. The main tuning control covers each of these megacycle ranges with

a dial calibrated at one-kilocycle intervals. The frequency stability of the receiver is consistent with the calibration of one kc per dial division even at the highest frequencies.

The accuracy and stability of the 51J-4 Receiver make it suitable for communication applications where it is desired to receive known frequencies without searching or frequent readjustment. Thus it is possible to use the 51J-4 Receiver to replace or to supplement fixed tuned crystal controlled receivers or to afford the advantages of crystal control in services where it is impractical to employ separate crystals for a large number of frequencies. The high stability is of great advantage in FSK service.

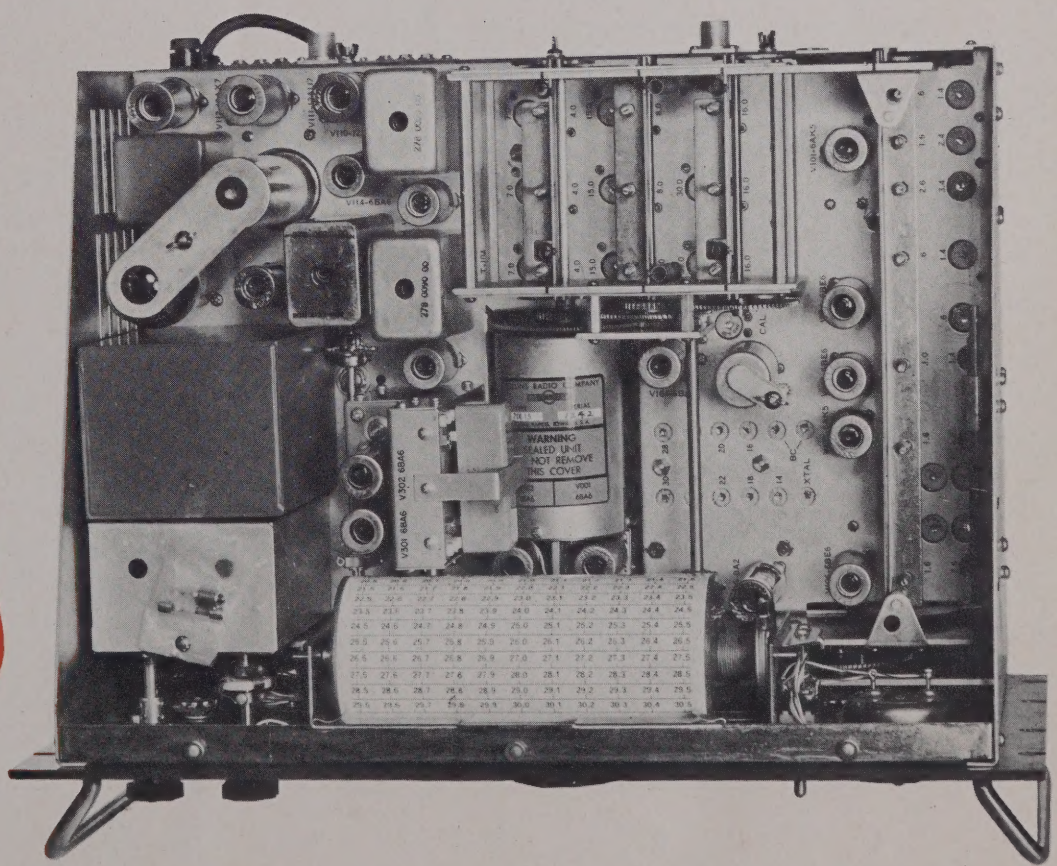
A second important field of usefulness for this receiver is in laboratory work where it may be employed as a sensitive and accurate frequency measuring instrument.

The unusual tuning and stability features of the 51J-4 Receiver are obtained without resort to complicated gadgetry and without increasing the number of circuit components over that required in more conventional designs. Double conversion is employed, with the first IF permeability tuned over a one-megacycle range. A total of ten crystals provides stable first injection frequencies for each of the 30 one-megacycle bands. A highly stable, sealed, permeability tuned oscillator operating in the range 2-3 megacycles provides the second injection frequency. Only six sets of linearly permeability tuned circuits are required to cover the entire signal frequency range .54 to 30.5 megacycles and a simple mechanical drive system is arranged to subdivide this range into 30 one-megacycle bands.

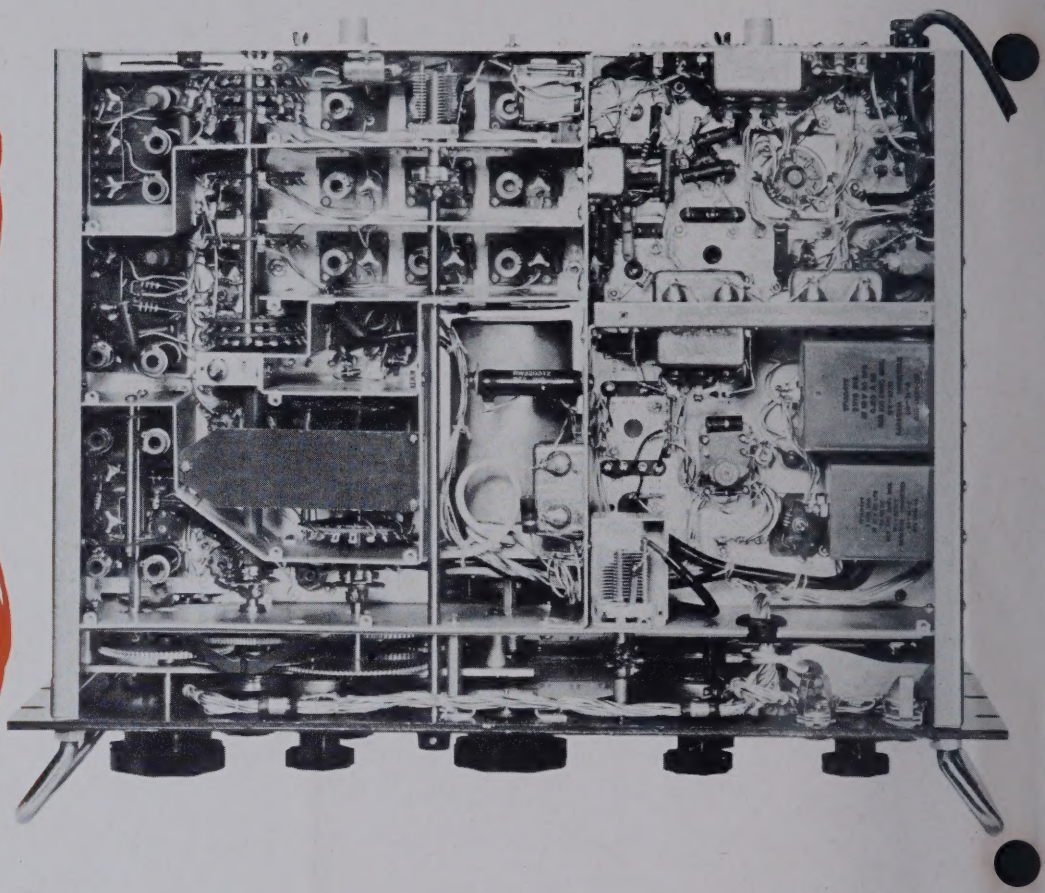
It has been possible in the design of the 51J-4 to achieve performance as regards sensitivity, noise figure, selectivity, suppression of spurious responses and cross modulation equal to that obtained in the best more conventional designs not having the 51J's special tuning and stability features.

The first injection oscillator, which has the greatest effect in controlling the frequency of the 51J-4 Receiver,

51J-4 TOP VIEW



51J-4 BOTTOM VIEW

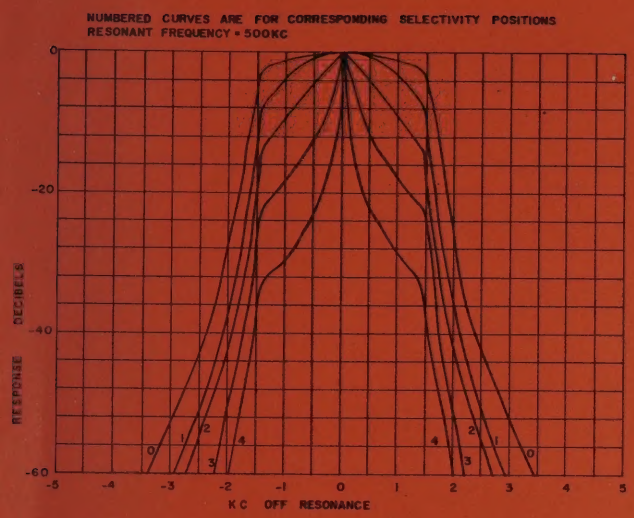


employs crystals having an accuracy of approximately .002 per cent. The tuned oscillator, second IF amplifier, and BFO, which are of secondary importance in determining the frequency by reason of their lower frequencies, are designed for high stability under varying conditions of temperature, humidity and vibration. The combined effects of all parts of the circuit result in a total setting error and drift of less than one kilocycle under normal conditions of operation and a maximum error of less than two kilocycles under extremes of test conditions. These figures apply to the entire tuning range of the receiver.

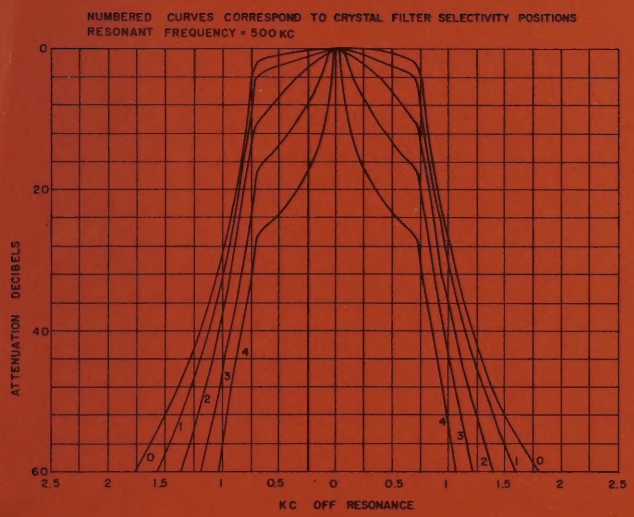
The inherent stability of the receiver is supplemented by a built-in 100 kc crystal calibration oscillator which may be adjusted for zero beat against standard frequency transmission from WWV. Thus, precision crystal check points are available at each 100 kc interval throughout the tuning range of the receiver and a correcting knob is provided to permit the dial fiducial mark to be set to agree with the nearest check point. Interpolation accuracy between check points is of the order of 200 cycles.

In addition to the innovations in the tuning and frequency control portions of the design, the 51J-4 Receiver incorporates advanced circuitry in other respects important in a communication receiver.

A very effective AVC is incorporated in the 51J-4. By use of d-c amplification of the AVC the audio output is held constant within 5 db over signal input ranges of 5 uv to 100,000 uv. The use of amplified AVC also allows the use of a low impedance AVC line which makes possible extremely quick recovery from strong signal or static overloads. The AVC also has an extremely short time constant and as a result of these features it is possible to use breakin operation with a nearby transmitter. An effective series diode noise limiter is incorporated. This limiter clips noise at a level equivalent to 30% modulation. A switch is provided



3 kc Mechanical Filter Selectivity Curves



1.4 kc Mechanical Filter Selectivity Curves

51J-4
SELECTIVITY CURVES

on the front panel to remove the noise limiter from the circuit if desired.

The following controls are located on the front panel:

RF gain	Meter switch
Audio gain	Crystal selectivity
BFO on-off	Crystal phasing
Calibrator on-off	Power off-on-standby
BFO pitch	Megacycle tuning (bandswitch)
Mechanical Filter Selector	Main tuning
AVC on-off	Fiducial corrector
Noise limiter on-off	Ant. trim

Screwdriver adjustments for calibrator crystal frequency, S meter zeroing is located on the chassis.

Permeability tuning is used throughout the RF stages of the receiver allowing a fairly constant L/C ratio over the entire range. This, in conjunction with a 6AK5 RF amplifier tube, gives excellent sensitivity and signal-to-noise ratio. Since only 13 coils are needed to cover the tuning range of the receiver, tracking is extremely simple. Only 26 adjustments are necessary to completely align and track the RF circuits, fewer than are required for most conventional receivers of equivalent coverage. The use of a high frequency first IF together with three tuned circuits in the RF portion of the receiver gives excellent image response performance. Images are down more than 40 db throughout the entire tuning range. Care has also been taken to apportion gain throughout, resulting in extremely good cross modulation and strong signal performance.

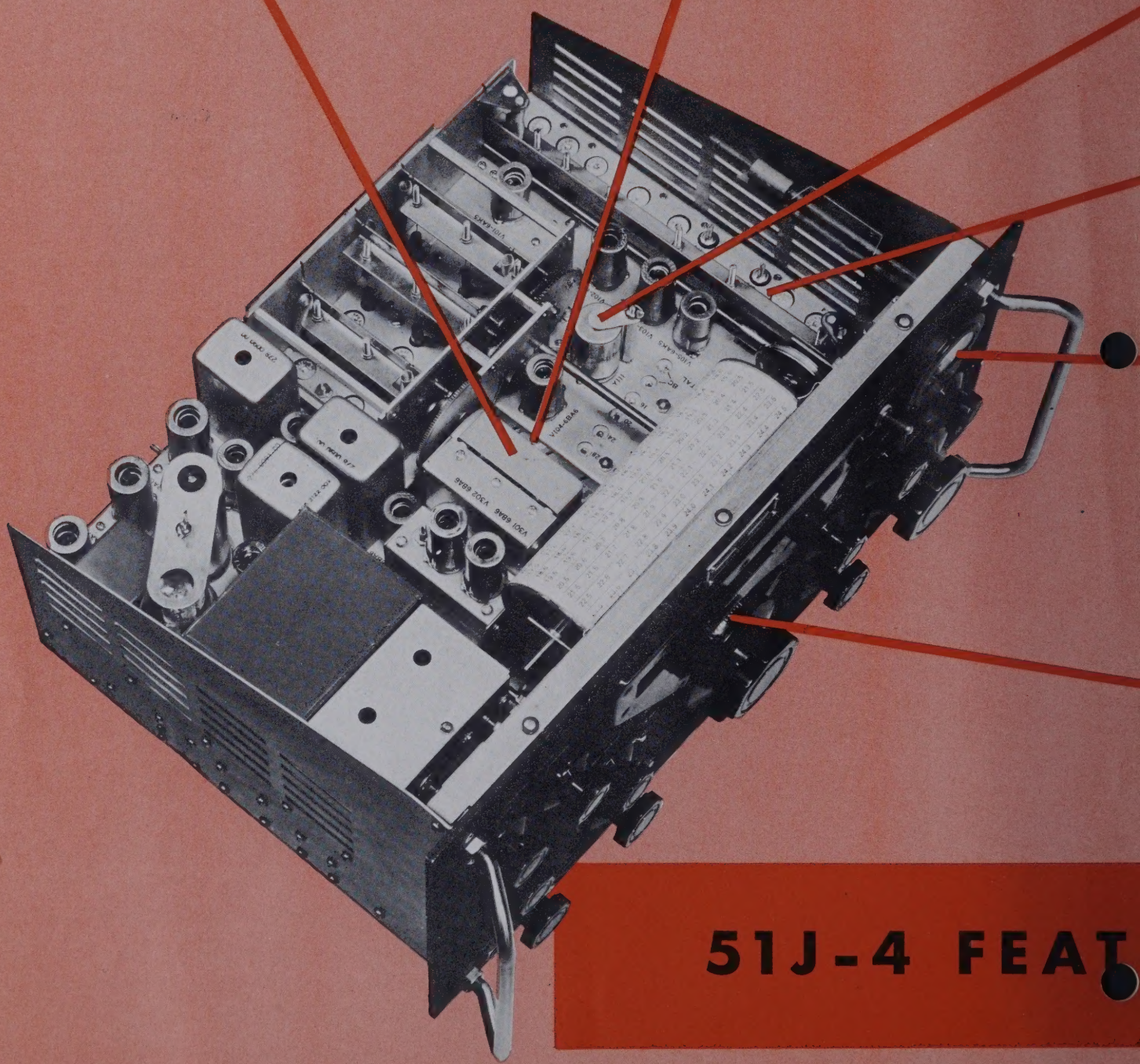
The last IF, operating at 500 kc, allows a choice, from the front panel, of three bandwidths, 1.4, 3.1 or 6 kc, depending on the Mechanical Filters selected.

MECHANICAL FILTERS

Ideal rectangular-shaped passband for a particular type of reception may be selected by front panel control.

SEALED OSCILLATOR

Incorporates all possible stabilizing measures. Tuning elements are mechanically loaded to insure reset accuracy and virtually eliminate effects of shock and vibration.



51J-4 FEAT

CALIBRATE OSCILLATOR

A marker is available at each 100 kc point, allowing zero adjustment of the dial at each harmonic throughout the tuning range.

PERMEABILITY TUNING

Band changing is accomplished by step differential positioning of tuning cores within each coil until inductance limit is reached, then changing coils and repeating.

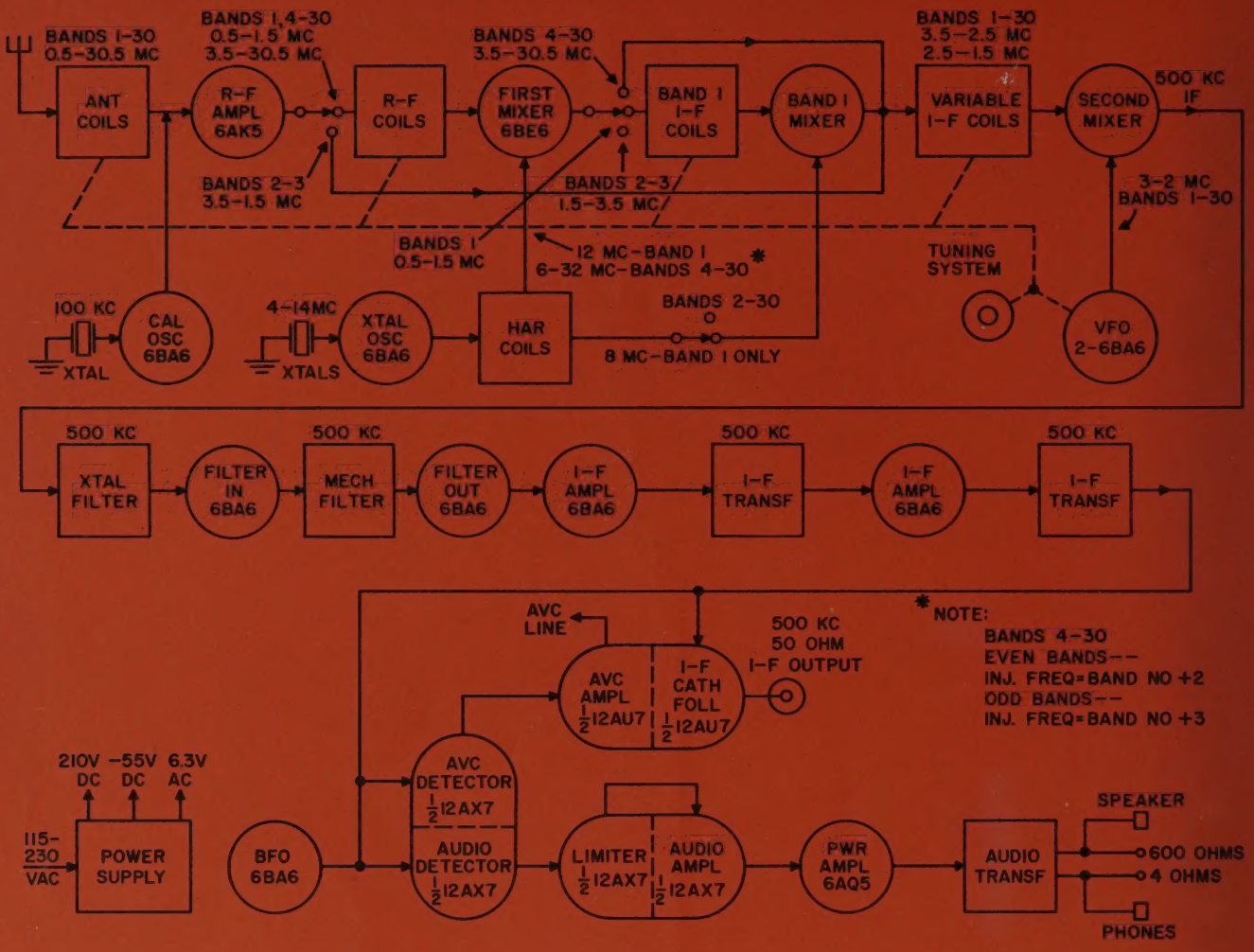
LEVEL METER

A meter is provided for checking RF input or audio output levels. It is calibrated in 20, 40, 60, 80, and 100 db above AVC threshold when reading RF input. When reading audio output, the meter is calibrated from —10 to +6 db, zero reference being 6 milliwatts into a 500 ohm load.

LINEAR CALIBRATION

The main dial is divided into 30 one-mc bands, each of which is covered by 10 turns of a 100 division dial calibrated at one kc intervals. The receiver's frequency stability is consistent with this calibration even at the highest frequencies.

RES



51J-4 BLOCK DIAGRAM

The very steep skirt selectivity of the mechanical filters is extremely advantageous when operating in crowded bands, by making it possible to tune out whichever side band has interference. As the receiver is tuned across a band of frequencies, signals suddenly appear and disappear. This is because of the absence of broad skirts which "drag out" the tuning of receivers that have conventional IF strips.

A headphone jack is provided on the front panel. When the head phones are used, the four ohm speaker output is disconnected. In addition to the speaker terminals, a 500-ohm audio output, coaxial RF input, 50-ohm IF output and terminals for standby operation are provided on the rear of the chassis. Spare terminals are provided to allow other functions to be brought out as required for special applications. A heavy duty a-c power cord extends from the rear of the chassis.

The 51J is constructed in a standard panel and shelf assembly suitable for mounting in a standard rack cabinet. Overall dimensions are 19 inches panel width, 10½ inches panel height, and 13 inches depth behind the panel. Damage from dust and other foreign matter is prevented by a dust cover which fits over the top of the chassis. Optionally the 51J can be supplied in a table mounting cabinet with separate speaker.

Accessory items such as racks, panel mounted speakers, and diversity combining panels are also available.

SPECIFICATIONS

FREQUENCY RANGE
.54 to 30.5 megacycles.

TYPE OF RECEPTION
AM, CW, MCW and FSK.

TYPE OF CIRCUIT
Crystal controlled Double Conversion Superheterodyne.

CALIBRATION
One kilocycle per dial division. Direct reading in megacycles and kilocycles. One turn of main tuning dial covers 100 kilocycles on all bands.

TUNING
Linear, divided into 30 one mc bands.

FREQUENCY STABILITY
Dial calibration at room temperature is within 300 cps, if the nearest 100 kc point is used to adjust the fiducial.

SENSITIVITY
5 microvolts or less for 10 db sig/noise ratio and 1 watt output into 600 ohms, except band 1 (.54 to 1.5 mc) 15 microvolts or less.

SELECTIVITY
Dependent upon Mechanical Filter selected. For F-500B-31 2.80 to 3.40 kc wide at 6 db down; 7.0 kc max. at 60 db down.

IMAGE RESPONSES
.54 to 7 mc 90 db or more.
7 to 14 mc 70 db or more.
14 to 30.5 mc 40 db or more.

AUTOMATIC GAIN CONTROL
Not more than 5 db increase in audio power output with increase in RF input signal from 5 to 125,000 microvolts.

INPUT-OUTPUT METER
Input calibrated in db above AVC threshold.
Output calibrated —10 db to +6 db (6 mw ref. level).

LIMITER
Improved series diode type.

AUDIO OUTPUT
4 and 600 ohms impedance. 1.5 watts at 1000 cps with less than 15% distortion overall. "S" meter may be switched to read audio output.

AUDIO FREQUENCY RESPONSE (Overall)
200 cps not more than 3 db down. 2500 cps not more than 3.5 db down when 6 kc filter is used.

RF INPUT
Single ended coaxial. Antenna trimmer will resonate input circuit when used with any normal antenna. Break-in relay mounted internally.

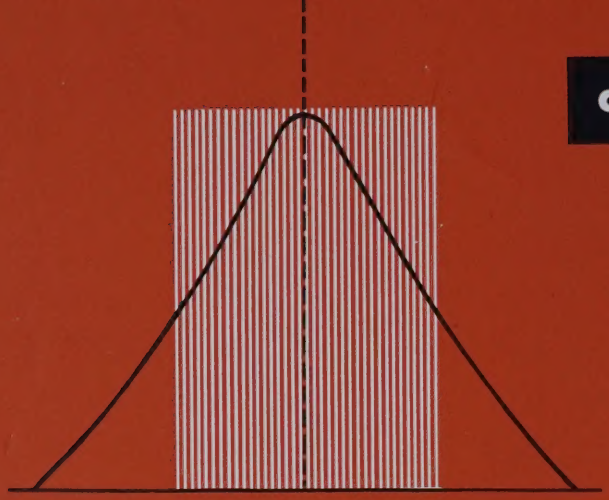
CLIMATIC CONDITIONS
—20°C to +50°C.

RELATIVE HUMIDITY
Up to 95%.

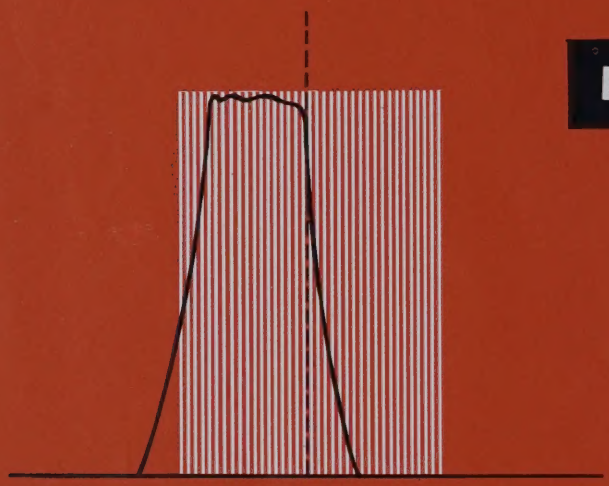
POWER REQUIREMENTS
85 watts 45/70 cps, 115 volts or 230 volts by reconnection on power transformer.

DIMENSIONS
Panel—10½ inches high, 19 inches wide, notched for rack mounting.
Optional metal cabinet: 21⅛ inches wide, 12¼ inches high and 13⅛ inches deep.
Speaker available in metal cabinet 15 inches wide, 10⅝ inches high and 9⅛ inches deep.

WEIGHTS
Receiver—35 pounds.
Cabinet—20 pounds.
Speaker—12½ pounds.



Conventional Selectivity Curve



51J-4 Selectivity Curve

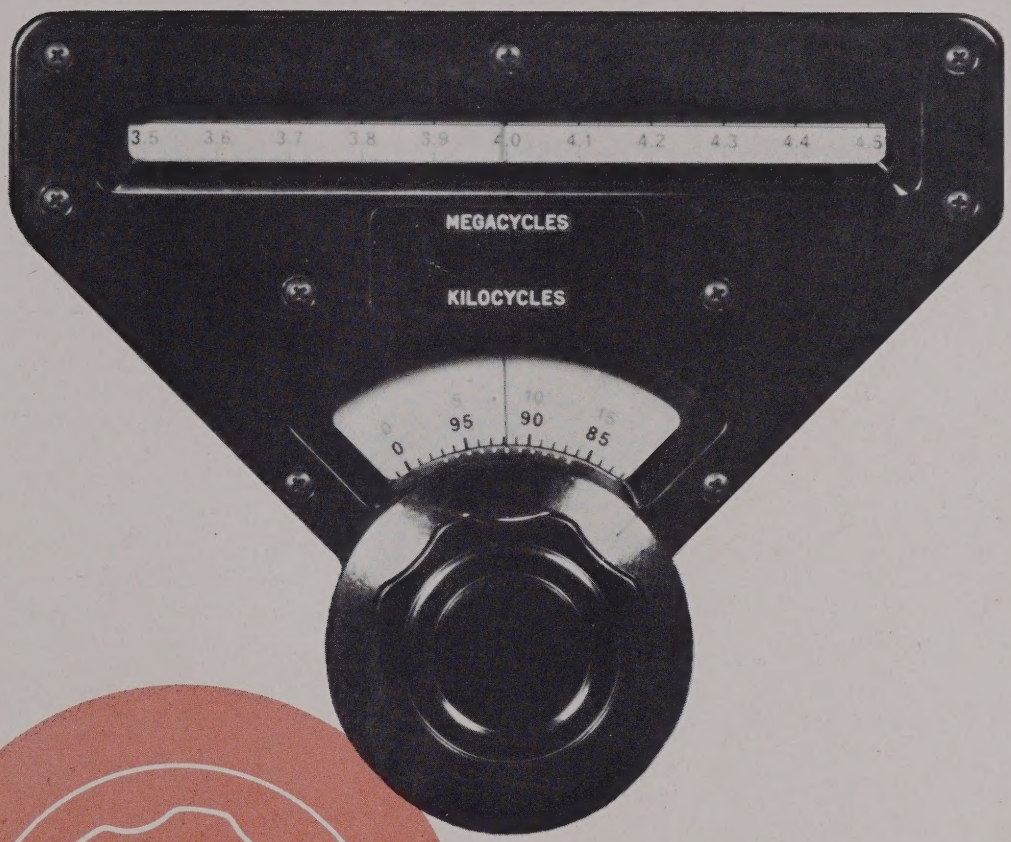
51J-4 Selectivity Curve

THE NEARLY RECTANGULAR SELECTIVITY CURVE OF THE 51J-4 PERMITS IDEAL TUNING PROCEDURES FOR AM OR SINGLE SIDEBAND

A receiver with conventional IF strip is usually tuned as shown in curve A at left. The carrier is set at the center of the selectivity curve, thereby dividing the receiver's bandwidth between the two sidebands of the received signal. Since all of the transmitted intelligence is included in each sideband, a substantial reduction in heterodynes and other interference can be attained by narrowing the receiver's bandwidth and tuning to only one sideband and the carrier as shown in curve B. However, this cannot be done with the conventional rounded IF curve, illustrated at A, because tuning the receiver to a sideband moves the carrier down onto the side of the selectivity curve and reduces the level of the carrier below the level of one of the sidebands. This causes the familiar distortion (overmodulation at the receiver's detector) that always results when a conventional receiver's passband is not centered on the carrier.

Therefore, the bandwidth of the conventional receiver must be split between two sidebands while the 51J-4 receiver, with its nearly rectangular selectivity curve, is designed to be tuned as shown in curve B. Only the carrier and one sideband are included in the receiver's passband. The sideband that is most nearly in the clear is selected, permitting the other sideband, and any signals that are interfering with it, to be eliminated. The 51J-4 is normally tuned to one side of the received signal until the higher audio frequencies are heard, indicating that the receiver is set up as shown in curve B. When tuned in this manner, the 3-kc mechanical filter in the 51J-4 passes the same audio bandwidth as a conventional receiver having a bandwidth of approximately 6 kc.

As shown in C, the width and shape of the 51J-4 selectivity curve is ideally suited to SSSC reception. This selectivity curve, combined with the stability made possible by a crystal-controlled high-frequency mixer and very stable low-frequency oscillator, makes the 51J-4 an excellent SSSC receiver. When tuning SSSC signals on the 51J-4, turn on the BFO, set the audio gain at maximum, and adjust the volume with the RF gain control. Where the lower sideband is being transmitted, set the BFO pitch-control knob to the right. This sets the BFO carrier at the high edge of the sideband, as shown in C, and about 1500 cycles above the receiver dial setting. When the high sideband is being transmitted, the BFO knob must be set to a position to the left in order to place the BFO carrier at the low edge of the sideband. Since the BFO carrier is inserted after the signal has passed through the mechanical filter, the carrier frequency does not necessarily have to be included in the IF passband. With the receiver set up as outlined above, carefully turn the main tuning knob until the voice being transmitted by the single-sideband station sounds natural.



Dial Accuracy

The tuning range .540 to 30.5 megacycles, is divided into 30 one-megacycle bands selected by a "megacycle" knob and indicated by a slide rule dial having graduations at one-tenth megacycle intervals. The main tuning control covers each of these megacycle ranges with a dial calibrated at one-kilocycle intervals.

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